Southwest Fisheries Center Administrative Report 25H, 1978
(Revised)

REPORT OF THE

THIRD NORTH PACIFIC ALBACORE WORKSHOP

HONOLULU, HAWAII

13-14 SEPTEMBER 1978

Edited by

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February 1979

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I. Introduction

The Third North Pacific Albacore Workshop was conducted at the National Marine Fisheries Service (NMFS) laboratory in Honolulu, Hawaii, on 13-14 September 1978. The event was part of a continuing informal arrangement established in 1974 between NMFS' Southwest Fisheries Center and the Far Seas Fisheries Research Laboratory, Shimizu, Japan, to promote and accelerate joint investigations into the biology, ecology, and population dynamics of North Pacific albacore, *Thunnus alalunga*. Two other workshops have been held; the first in Honolulu in December 1975 and the second at Shimizu in May 1977.

The third meeting was attended by scientists from the two principal agencies and by biologists representing the California Department of Fish and Game, the Oregon Department of Fisheries and Wildlife, the Washington Department of Fisheries, and Fisheries and Environment Canada. Participants are listed in Appendix A. Jerry A. Wetherall acted as chairman of the workshop. Norman W. Bartoo and Mark G. Pedersen were rapporteurs, assisted by Gary T. Sakagawa.

Richard S. Shomura, Director of the Honolulu Laboratory, welcomed the participants and reviewed the terms of reference for the workshop. He emphasized the growing need for international cooperation in research on highly migratory species and stressed the value of maintaining the close and productive ties between the Honolulu Laboratory and the Far Seas Fisheries Research Laboratory.

The chairman described the purposes of the workshop, which were:

(1) To review the status of the various North Pacific albacore fisheries during 1977 and 1978, to exchange fishery data, and to update basic statistical tables;

(2) to exchange views, ideas, and research results on a range of subjects related to albacore stock assessment and ecology, through the presentation and discussion of working papers;

(3) to produce this report containing the fishery review, the updated fishery statistics, summaries of the working papers, a current assessment of the North Pacific albacore resource, and recommendations for continued cooperative research.

Appendix B gives the agreed workshop agenda. A list of documents submitted to the workshop, including various data tables, statistical reports and working papers, is attached as Appendix C.[1]

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[1]Working papers were prepared solely for discussions at the workshop and were not intended for wide dissemination. Requests for copies should be directed to individual authors.

II. Review of Fishery Statistics

A. Trends in Catch

The estimated annual catches of North Pacific albacore from 1961 through 1977 are listed in Table 1 and plotted in Figure 1. The catches by Japanese vessels are compiled by the Fisheries Agency of Japan. Canadian catch statistics are gathered by Fisheries and Environment Canada. The statistics for the United States jig catch are derived directly from landings data furnished by California, Oregon, and Washington, on the assumption that all albacore caught by U.S. vessels are landed in one of these states. Estimates for the U.S. bait boat fleet reflect only the catch of those vessels submitting logbooks to the Inter-American Tropical Tuna Commission, but this includes most of the fleet. The balance is included with the U.S. jig catch. Excluded from the table is the catch taken in the last couple of years by bait boats and longliners of the Republic of Korea and Taiwan. This catch is unknown but it is considered to be only a small and insignificant fraction of the total North Pacific albacore harvest. Also omitted is a practically negligible catch by party boat anglers and other recreational fishermen in the U.S.

The general trend of the aggregate catch was upward over the 1961-76 period, the lowest catch being 42,185 metric tons (MT) in 1962 and the highest 122,804 MT in 1976. The catch records illustrate the increasingly dominant role of the Japanese pole-and-line fleet since it began a rapid expansion in 1971 (Table 2). Between 1971 and 1976 the Japanese pole-and-line catch increased from an annual average of about 25,000 MT to over 85,000 MT. In 1977, the total North Pacific albacore catch plummeted to 55,987 MT, due primarily to a sharp drop in the Japanese pole-and-line catch. However, the 1977 United States and Canadian landings were also substantially lower than in 1976, the United States jig landings being the lowest recorded since 1951. The estimated Japanese longline catch during 1977 was also less than in the previous year. While no specific figures were available for 1978, the Japanese pole-and-line catch through August was only slightly greater than in the previous year, and the United States jig catch, while showing improvement over the 1977 figure, was still expected to be below normal.

Workshop participants reviewed information and hypotheses bearing on the sudden drop in catch in the surface fisheries. There was considerable support for the idea that oceanographic conditions were primarily responsible. In particular, the weak development of frontal structure was thought to be a major cause of poor fishing conditions, both in the Japanese pole-and-line fishery in the western North Pacific and in the United States and Canadian jig and bait boat fisheries of the eastern North Pacific. While below-average availability and weak temperature fronts were considered the main limiting factors in the eastern Pacific, in the case of U.S. vessels reduced catches were also attributed to a relatively high proportion of potential fishing days lost due to rough seas and other weather-related factors.

B. Trends in Catch Per Unit Effort (CPUE)

In each of the three major fisheries annual catch-per-unit-effort (CPUE) statistics were compiled over the 1961-76 period. Additional CPUE statistics for 1977 were available for Japanese pole-and-line vessels and U.S. jig boats (Table 3). The data for 1961-76 were normalized by dividing each year's CPUE by the average CPUE computed over the 16-yr period. Figure 2 and Table 3 present these normalized CPUE statistics. In none of the five sets of normalized CPUE data is the 16-yr trend significantly negative. In fact, the only significant regression is with the "adult area" longline CPUE, and here the long-term trend is positive. However, a linear model may not adequately describe changes in CPUE over the entire period.

Catch rates in the Japanese pole-and-line fishery between 1961 and 1969 showed a slightly declining trend, but then increased generally through 1976 with higher variation. In 1977 the actual pole-and-line CPUE (Table 3) dropped sharply to the lowest level in the 17-yr period. During the 1970's, as the pole-and-line fleet has grown, the northern and eastern boundaries in the fishing grounds have also expanded. More fishing effort has been exerted on albacore in the Kuroshio Front region, where the average size of albacore in the catch is less than it is further south.

The normalized catch rates for the U.S. jig fleet show relatively high variation from year to year, presumably reflecting changes in availability. Since 1961 there have been two periods of relatively high catch rates; 1962-63 and 1967-70. Catch rates during the 1970's have been generally below the long-term average and in 1977 the actual catch rate was the lowest recorded during the 17-yr period.

The remaining sets of CPUE statistics are from the Japanese longline fishery. When compiled over the entire albacore longline grounds the CPUE showed an increase from 1961 to 1966, then a decline from 1967 to 1971, followed by a rise to above-average catch rates in 1973 and 1974. Catch rates in 1975 and 1976 were below average. A different pattern is seen when CPUE statistics are examined over smaller segments of the North Pacific grounds. North of lat. 25°N the longline catch is composed of relatively young albacore, and the CPUE there has been below the long-term average during 7 of the last 8 years on record. In contrast to this is the trend in CPUE on the larger, adult albacore taken south of lat. 25°N. Here during the same period, 1969-76, the CPUE dropped below average only 3 years out of 8.

In all of these series of statistics a crucial question is whether changes in CPUE reflect real changes in stock size or whether they are due to other events. In general, CPUE is a complex function of several factors, including the actual abundance or size of the harvestable albacore stock, the availability of albacore in a given fishing area, the degree to which albacore forage organisms are concentrated by thermal fronts and other oceanographic conditions, and the distribution of the fishing vessels relative to the fish. Some of these factors can be observed and measured; others cannot. For example, year-to-year changes in oceanographic conditions and fleet distribution may be charted, but no independent estimates of stock size or stock distribution are available.

In the case of the surface fisheries especially, CPUE is strongly affected by oceanographic factors such as the development of frontal structure, by spatial and temporal variations in effort distribution, and by fluctuations in year-class strength. While the effects of these factors are confounded in the CPUE statistics, there is considerable evidence that the reduced CPUE indices in 1977 were a result of abnormally weak development of temperature fronts. However, without additional information, particularly unbiased age-specific abundance indices, other causes cannot be ruled out. For example, fluctuations in recruitment might be a factor, since cohort analyses have shown a fourfold to fivefold variation in year-class strength.

Inconsistencies between the various sets of CPUE data described here appear to be systematic, rather than simply statistical in nature. The indices clearly represent different processes, and different combinations of effects and influences. Understanding the processes and determining which index, if any, is appropriate for measuring changes in stock size are critical issues in albacore stock assessment.

III. Presentation and Discussion of Working Papers

A. Population Dynamics and Resource Assessment

An assessment of the North Pacific albacore resource was made by Shiohama (WP-1) using the generalized production model and the computer program PRODFIT. The analysis was based on 1) annual normalized CPUE statistics, from 1965 to 1976, representing the Japanese pole-and-line and longline fisheries and the United States jig fishery, and 2) total catch statistics from the Japanese pole-and-line and longline fisheries and the combined eastern Pacific catches of the United States and Canada. The Japanese pole-and-line statistics were separated into two sets, one representing the "Frontal Area" in the northern part of the fishing grounds, and the other representing the remaining region of pole-and-line fishing. The longline data were also divided into two sets, one from the region north of lat. 25°N where young albacore predominate and one representing the area between the equator and lat. 25°N, where larger, more mature albacore are taken. In fitting the production model Shiohama considered two cases with respect to the Japanese pole-and-line data; first, that the southern limit of the Frontal Area was fixed at lat. 35°N; and second, that this boundary shifted from year to year depending on oceanographic conditions. In each case the model was fitted using a range of shape parameters (the parameter "m" in the production model). There was little difference in the goodness of fit among different m values, owing to the absence of observations from the region of the production curve's right-hand limb. Considering all sets of data and assumptions, the maximum sustainable yield (MSY) of North Pacific albacore was judged to be in the range of 100,000-120,000 MT per year.

As an alternative to the standard production model analysis, which ignores age-structure, Wetherall and Yong (WP-5) considered the use of age-specific abundance indices and effective effort statistics to estimate vital parameters of albacore population dynamics and to predict stock size and catch. They described a simple technique which integrates available statistics on relative stock size and age composition and produces both steady state information for determining general harvest strategy and short-term predictions of abundance and catch for use in tactical planning. First attempts to apply the method to North Pacific albacore data over the period 1955-75 were unsuccessful as a result of statistical problems. These are being diagnosed and work on the model and its applications is continuing.

Whereas the aim of Wetherall and Yong was to forecast abundance and catch over the whole stock range, Shiohama (WP-2) reported Japanese efforts to predict albacore catches in their pole-and-line fishery alone. Japanese scientists have demonstrated a good relationship between the catch of 4-year-old fish by longliners and 5-year-olds taken by pole-and-line vessels a few months later [fish of the same year-class]. However, the practical application of this predictor will require speedier data processing procedures than are now available. Relationships have also been demonstrated between February albacore landings in Wakayama Prefecture and total annual albacore landings by the Japanese pole-and-line fleet, especially with data collected since 1971, when the fishery in the Frontal Area developed. This forecasting approach seems to require the "normal" development of the frontal grounds, because it failed in 1977 when the usual conditions in the Frontal Area did not materialize.

B. Fishery Oceanography and Biology

Laurs (WP-6) discussed several factors believed to be responsible for the low U.S. albacore catch and poor fishing conditions in 1977: 1) albacore were not as abundant or available as in 1976 off Oregon and Washington, perhaps due to a delay in the eastward summer migration, 2) albacore were more scattered than usual due to poorly developed upwelling fronts which concentrate albacore forage organisms, 3) despite fairly adequate concentrations of albacore south of San Francisco, many fish there seemed not to "bite" as readily as usual, and 4) the full potential of nominal fishing effort was not realized as a result of several periods of inclement weather and rough seas, which either kept vessels in port or made fishing difficult.

A paper by Kikawa (WP-3) dealing with fishing conditions in the Japanese pole-and-line fishery in 1977 and 1978 was presented by Mr. Shiohama and Dr. Hayasi. The abnormally poor conditions experienced in 1977, and again in 1978, were attributed to two factors: 1) below average availability of albacore resulting from unfavorable oceanographic conditions in the Frontal Area; it was shown that cold water masses at lat. 35°N, between long. 150°E and 170°E, had intruded much closer to the surface in 1977 than in 1976, reducing the area of preferred albacore habitat; 2) shifts in the age-structure of the albacore stock, resulting in a reduction of the average size of albacore in the catch. Four-year-old fish dominated the Yaizu market albacore landings from 1974 through 1976, but were overshadowed by 3-year-olds in 1977. It is expected that 2-year-olds will predominate in the 1978 landings.

Some preliminary results of an oceanographic investigation in the Kuroshio Extension fishing grounds by the RV Shoyo Maru were reported in a paper by Morita (WP-4). In May and June 1978, oceanographic conditions were measured in conjunction with pole-and-line fishing and albacore tagging east of long. 155°E. Profiles of temperature and other parameters were charted. Analysis of these data will help further the understanding of the complex relationships between fishing conditions and oceanographic processes.

In another working paper, Laurs (WP-7) reported early results of experiments using tetracycline-injected albacore to study "daily" ring formation in albacore otoliths. The study's objective is to determine whether the fine rings are actually formed on a daily basis as many age-and-growth investigations now assume. During 1977 and 1978 nearly 1,800 albacore were caught by chartered U.S. bait boats in the eastern North Pacific, then dart-tagged, injected with 150 mg of oxytetracycline and released. Seventeen otoliths from 45 recovered fish have been analyzed so far. Tentative results are that 1) there is considerable variation in the time required for a single ring to be formed, 2) no more than one ring is formed per day, and 3) in most cases more than 1 day is required for each ring added. The study suggests the possibility of some positive bias in growth rate estimates determined with the otolith "daily-increment" procedure.

IV. Stock Evaluation

A. Estimates of Maximum Sustainable Yield (MSY)

Estimates of MSY for the North Pacific albacore resource were reviewed. Two methods have been employed to estimate MSY: 1) the generalized production model [used by Shiohama and Morita in 1975 and by Shiohama (WP-1) in this workshop], and 2) a model linking stock-recruitment relationships and yield-per-recruit functions [used by Wetherall and Yong in 1975]. When the Schaefer form of the production model is considered, results from the two approaches have been similar and MSY has been estimated to be between 100,000 and 120,000 MT (Table 4).

As a result of the special partitioning he used and the differences in time periods considered, the normalized CPUE statistics reported by Shiohama in WP-1 are somewhat different from those given here in Table 3; nor are his total catch figures quite the same as those listed in Table 1. Because Tables 1 and 3 give the most up-to-date statistics, a series of production models were fitted to these data following the 1978 workshop. When the Schaefer version was used and data from 1965 to 1976 were analyzed, MSY was estimated to be 207,000 MT, compared to Shiohama's corresponding estimate of 113,000 MT (Table 4). These MSY's would be achieved at effort levels 180% and 27% higher than the 1976 level, respectively. When data covering the entire 1961-76 period were treated, the Schaefer model estimate of MSY was 170,000 MT at an effort level 120% greater than in 1976. Even higher estimates were obtained when non-Schaefer forms of the model were examined.

One difficulty with these production model estimates is that in each case there is relatively little variation in CPUE and effort, and data are not available from the region of the right hand or "descending" limb of the curve, i.e., the region of overfishing (Figure 3). As a result, the MSY parameters are estimated with very low precision. For example, approximate 95% confidence limits on MSY were estimated to be [55,000 MT, 171,000 MT] using Shiohama's data and the Schaefer model, and [0 MT, 648,000 MT] and [0 MT, 509,000 MT] for the two cases above employing updated statistics. One can have no confidence in MSY estimates falling so far outside the range of observed catches.

The foregoing discussion assumes that the fundamental assumptions of the production model are satisfied. If so, then the problems of estimating MSY with reasonable precision are basically statistical. While some of the current estimates of MSY and optimum effort amount to projections beyond the limits of experienced catch and effort and are therefore highly imprecise, precision should increase as more data are added and as the ranges of catch and effort expand. In the meantime the Schaefer model regressions indicate that average stock size, as indexed by CPUE, has not been significantly reduced by the effort exerted to date.

However, even if such improved statistics become available standard production model analyses may not give very useful results, since several kinds of systematic bias may exist. Among these are 1) the production model analysis assumes a single, homogeneous group of fish with uniform rates of biomass production and fishing mortality, whereas in fact both productivity and fishing mortality are age-specific. The average productivity and yield potential of the stock therefore depend heavily on age-structure and the age-specificity of fishing mortality. The albacore resource is composed of several year-classes, and the three major fisheries harvest different (but overlapping) segments of the exploitable population; 2) the analyses so far have assumed a single North Pacific albacore stock, whereas a more complicated stock structure, involving at least two stocks, has been hypothesized on the basis of extensive tagging studies; 3) for reasons elaborated above, changes in CPUE may not faithfully reflect real changes in stock size.

If these conditions exist then the MSY estimates computed using the standard production model are meaningless and other methods must be developed to estimate the average annual yield potential and to provide reliable guidance for judging the status of the stock. Since year-to-year variations in recruitment and availability are high, more sophisticated, dynamic assessment measures will be needed for effective analysis of fishing policies.

B. Condition of Stock

The abrupt decline in the catch and CPUE of North Pacific albacore in 1977 in the United States and Japanese surface fisheries has focused attention on the need for careful monitoring of the stock and an evaluation of fishing strategy and practices. The conclusion of workshop participants was that environmental conditions--particularly the abnormally weak development of frontal structure in the principal fishing grounds--were probably the chief cause of a sudden drop in availability and/or catchability, and hence a reduction in catch and catch rates. A second possibility is that recruitment, known to undergo fairly wide natural variation, was relatively low during the 1975-77 period. A full evaluation of this hypothesis would require careful examination of unbiased age-specific abundance indices. Such measures have not yet been constructed. In these two particular explanations, fishing effort itself is not regarded as a principal cause of the reduction in catch and catch rates; availability is presumably dictated by environmental conditions and recruitment fluctuations are seen as independent of spawning stock size.

However, serious questions about overfishing cannot be neglected. Here we distinguish between two types of overfishing: 1) In growth overfishing recruitment is not affected by fishing at the prevailing levels of effort, but the average size of harvested fish is below the optimum size from the standpoint of maximizing yield per recruit. Studies have shown that this type of overfishing is characteristic of the North Pacific albacore harvest; given the present constraints and configuration of the surface fisheries, maximization of yield per recruit is probably not feasible. However, the concentration of the Japanese pole-and-line fleet on increasingly smaller albacore in the northern reaches of the Frontal Zone is clearly worsening the growth overfishing situation. 2) The more serious type of overfishing is recruitment overfishing, which results when fishing mortality reduces spawning stock to levels so low that recruitment is impaired. Is it possible that the rapid growth in the aggregate albacore catch (as experienced prior to 1977), coupled with the downward shift in size selectivity, is eroding the reproductive capacity of the albacore stock? To help answer this question, reliable methods must be developed to monitor both recruitment and reproductive capacity. In the meantime, while most production model analyses indicate that fishing effort is still less than the level producing MSY, this evaluation should be viewed circumspectly. Further, for reasons discussed above, the validity of the standard production model as a guide to management analysis for North Pacific albacore must be investigated critically.

V. Recommendations for Further Research

A. Highest Priority Research Task

The research most urgently needed is a thorough evaluation of stock assessment techniques. This work should include 1) analysis of the assumptions, data requirements, robustness, limitations, effectiveness, and appropriateness of the standard methods now in use, and 2) a plan for surmounting the shortcomings of present techniques and for assuring that the critical needs of stock monitoring and fishery evaluation are fully met. This task should be given the highest priority.

B. Other Research Needs

In addition to this major research requirement, there are several other areas needing special attention and emphasis. Specifically,

1) The U.S. system of vessel logbooks, fishermen interviews, and port sampling for size composition must be continued and funded at effective levels. The system should be evaluated from the standpoint of statistical design so that it is as efficient and effective as possible given the basic needs of stock assessment and fishery analysis. [This evaluation would logically be done after or in conjunction with V. A. above.] The U.S. sampling effort should be extended to cover the bait boat fleet.

2) In the Japanese pole-and-line fishery improvements are needed in the measurement of fishing effort. Actual days of fishing should be recorded rather than just days of successful fishing and other measures of effort, such as the number of pole-days of fishing, should be considered.

3) In the Canadian fishery, the collection of logbooks data from albacore trollers should be strengthened.

4) Statistics on the operation of the longliners and bait boats from Taiwan and the Republic of Korea should be obtained and added in future analyses of the albacore resource.

5) The historical size- and age-composition of the albacore catch should be determined using the best available data and the best procedures for assigning age and for combining data from different fisheries, areas, and time periods.

6) The fishing power coefficients for U.S. jig vessels should be re-estimated taking into consideration new information on the use of navigational equipment and other fishing aids.

7) The relationships between fish availability, fishing success, and oceanographic conditions, such as frontal structure development, should be studied further, and taken into consideration in evaluations of stock conditions.

8) Studies on albacore migration and stock identity should be continued and alternative stock structure hypotheses should be considered in future stock assessments.

9) Indices of recruitment and spawning biomass or population fecundity should be developed and monitored as a regular part of stock appraisal.

10) Comprehensive descriptive profiles should be developed for each fishery, preferably within the next year. These should include descriptions of such characteristics as fishing effort, type and number of vessels, species composition of catch, gear, and vessel parameters, fishing techniques and tactics, historical changes in technology, and estimates of catch capacity and new vessel construction.

VI. Arrangements for Next Workshop

The Fourth North Pacific Albacore Workshop will be hosted by the Far Seas Fisheries Research Laboratory in Shimizu, Japan. Dates for the meeting and other details will be worked out through correspondence between scientists of the Far Seas Laboratory and the Southwest Fisheries Center's Laboratory in La Jolla, California.

Table 1.--Catches of North Pacific albacore in metric tons, 1961-77.
(dashes indicate no estimate available)

Year	Japan[1]				United States[2]			Canada	Total[3]
	Pole-and-line	Longline	Other gears	Total	Pole-and-line	Jig	Total	Jig	
1961	18,636	15,999	--	34,635	2,837	12,054	14,891	4	49,530
1962	8,729	12,617	--	21,346	1,085	19,753	20,838	1	42,185
1963	26,420	11,445	--	37,865	2,432	25,142	27,574	5	65,444
1964	23,858	11,558	--	35,416	3,411	18,389	21,800	3	57,219
1965	41,491	11,214	121	52,826	417	16,461	16,878	15	69,719
1966	22,830	20,874	585	44,289	1,600	15,169	16,769	44	61,102
1967	30,481	24,374	520	55,375	4,113	17,814	21,927	161	77,463
1968	16,597	19,040	1,109	36,746	4,906	20,441	25,347	1,028	63,121
1969	31,912	18,006	1,480	51,398	2,996	18,826	21,822	1,365	74,585
1970	24,263	15,372	956	40,591	4,416	21,039	25,455	354	66,400
1971	52,957	10,915	1,262	65,134	2,071	22,196	24,267	1,587	90,988
1972	60,591	12,622	922	74,135	3,750	23,600	27,350	3,558	105,043
1973	69,640	16,000	1,922	87,562	2,236	15,652	17,888	1,720	107,170
1974	73,576	12,952	1,289	87,817	4,777	20,177	24,954	1,207	113,978
1975	52,157	9,931	568	62,656	3,243	18,926	22,169	101	84,926
1976	85,336	15,738	2,464	103,538	2,700	16,314	19,014	252	122,804
1977[4]	31,934	10,000	2,500	44,434	1,497	10,012	11,509	53	55,996

[1]Japanese longline catch for 1961-68 excludes minor amount taken by vessels under 20 gross tons. Longline catch in weight is estimated by multiplying annual number of fish caught by an average weight statistic.

[2]United States pole-and-line catch excludes minor amount taken by vessels not submitting logbooks to IATTC; this amount is included in the jig catch.

[3]Omitted are unknown but minor catches by United States sport fishermen and by longline and pole-and-line vessels of the Republic of Korea and Taiwan.

[4]1977 figures are preliminary.

Table 2.--Number of Japanese pole-and-line albacore vessels by size.

Year	Total number	Size of vessel (gross tons)			
		20-50	50-100	100-200	>200
1965	572	298	91	148	35
1966	571	299	71	167	34
1967	564	296	54	173	41
1968	561	276	60	170	55
1969	528	248	71	156	53
1970	512	220	91	140	61
1971	510	165	133	129	83
1972	554	131	162	116	145
1973	582	93	210	80	199
1974	716	136	255	98	227
1975	696	95	277	45	279
1976	653	51	318	17	267

Table 3.--Actual and normalized CPUE statistics for major North Pacific albacore fisheries, 1961-77.

Year	Actual CPUE[1]					Normalized CPUE[2]				
	Japan pole-and-line	United States jig	Japan longline[3]			Japan pole-and-line	United States jig	Japan longline[3]		
			"Young" area	"Adult" area	Entire area			"Young" area	"Adult" area	Entire area
1961	4.40	69.17	0.55	0.14	0.25	0.72	0.68	0.77	0.58	0.76
1962	7.22	124.59	0.67	0.14	0.30	1.18	1.23	0.94	0.58	0.91
1963	6.29	132.09	0.68	0.19	0.32	1.03	1.30	0.96	0.78	0.97
1964	6.86	97.61	0.90	0.19	0.40	1.12	0.96	1.27	0.78	1.21
1965	6.26	89.07	0.70	0.25	0.33	1.02	0.88	0.99	1.03	1.00
1966	5.94	90.45	1.20	0.27	0.54	0.97	0.89	1.69	1.11	1.64
1967	6.09	126.83	0.88	0.29	0.40	0.99	1.25	1.24	1.20	1.21
1968	5.34	135.23	0.84	0.29	0.38	0.87	1.34	1.18	1.20	1.15
1969	4.95	112.57	0.60	0.31	0.28	0.81	1.11	0.84	1.28	0.85
1970	6.13	127.39	0.66	0.27	0.31	1.00	1.26	0.93	1.11	0.94
1971	6.94	96.68	0.43	0.22	0.21	1.13	0.96	0.61	0.91	0.64
1972	6.25	61.08	0.63	0.30	0.30	1.02	0.60	0.89	1.24	0.91
1973	5.49	82.89	0.85	0.30	0.38	0.90	0.82	1.20	1.24	1.15
1974	7.81	105.17	0.64	0.30	0.34	1.27	1.04	0.90	1.24	1.03
1975	5.95	99.81	0.46	0.21	0.23	0.97	0.98	0.65	0.86	0.70
1976	6.13	69.22	0.66	0.21	0.30	1.00	0.68	0.93	0.86	0.91
1977	2.49	59.90	--	--	--	--	--	--	--	--
Mean 1961-76	6.13	101.24	0.71	0.24	0.33					

[1]Units: MT/vessel-day for Japan pole-and-line; fish/vessel-day for United States jig; fish/100 hooks for Japan longline.

[2]Actual CPUE divided by 1961-76 mean.

[3]"Young" area is 25°-45°N from October to March and 30°-45°N from April to September. "Adult" area is 0°-25°N. Entire area is 0°-45°N.

Table 4.--Estimates of maximum sustainable yield (MSY) for North Pacific albacore.

Case	Type of model	Years	Data points	$\hat{MSY}$ (10^3 MT)	95% confidence limits on MSY: Lower	95% confidence limits on MSY: Upper	$\left(\frac{\hat{F}_{opt}}{F_{1976}}\right)$	Source of data/estimates
1	Production model, 4-yr smoothing, m = 2 (fixed)	1965-76	9	113	55	171	1.27	Shiohama (WP-1, Table 3, case 1)[1]
2	Production model, 4-yr smoothing, m = 1.01 (variable)	1965-76	9	130	--	--	1.89	Shiohama (WP-1, Table 3, case 1)[1]
3	Production model, 4-yr smoothing, m = 2 (fixed)	1965-76	9	207	0	648	2.80	This report, Tables 1 and 2[2]
4	Production model, 4-yr smoothing, m = 0 (variable)	1965-76	9	638	--	--	--	This report, Tables 1 and 2[2]
5	Production model, 4-yr smoothing, m = 2 (fixed)	1961-76	13	170	0	509	2.20	This report, Tables 1 and 2
6	Production model, 4-yr smoothing, m = 0.99 (variable)	1961-76	13	224	--	--	3.90	This report, Tables 1 and 2
7	Production model, 4-yr smoothing, m = 2 (fixed)	1961-73	10	115	--	--	--	Shiohama and Morita, 1975 workshop
8	Yield per recruit/ spawner-recruit	1952-72	--	116	--	--	--	Wetherall and Yong, 1975 workshop

[1]The standardized effort for 1965 was corrected to 67,544 from the original value of 65,544.

[2]Normalized CPUE in these cases was computed by dividing actual CPUE by the 1965-76 mean, instead of the 1961-76 mean.

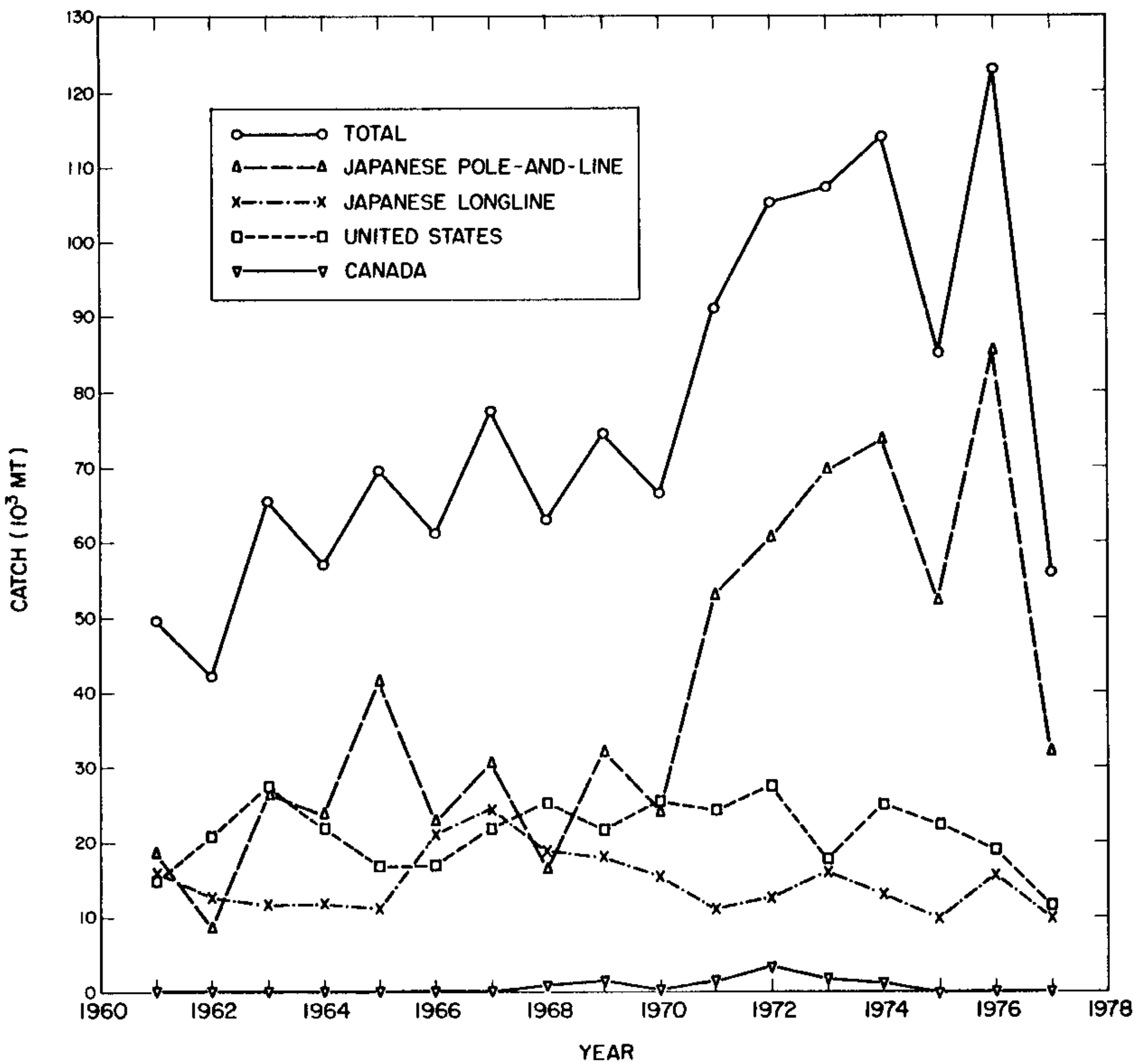

Figure 1.--Estimated annual catch of North Pacific albacore, 1961-77, in 10^3 metric tons. Total catch includes small amount taken in minor fisheries as well as the catch by the indicated major fisheries.

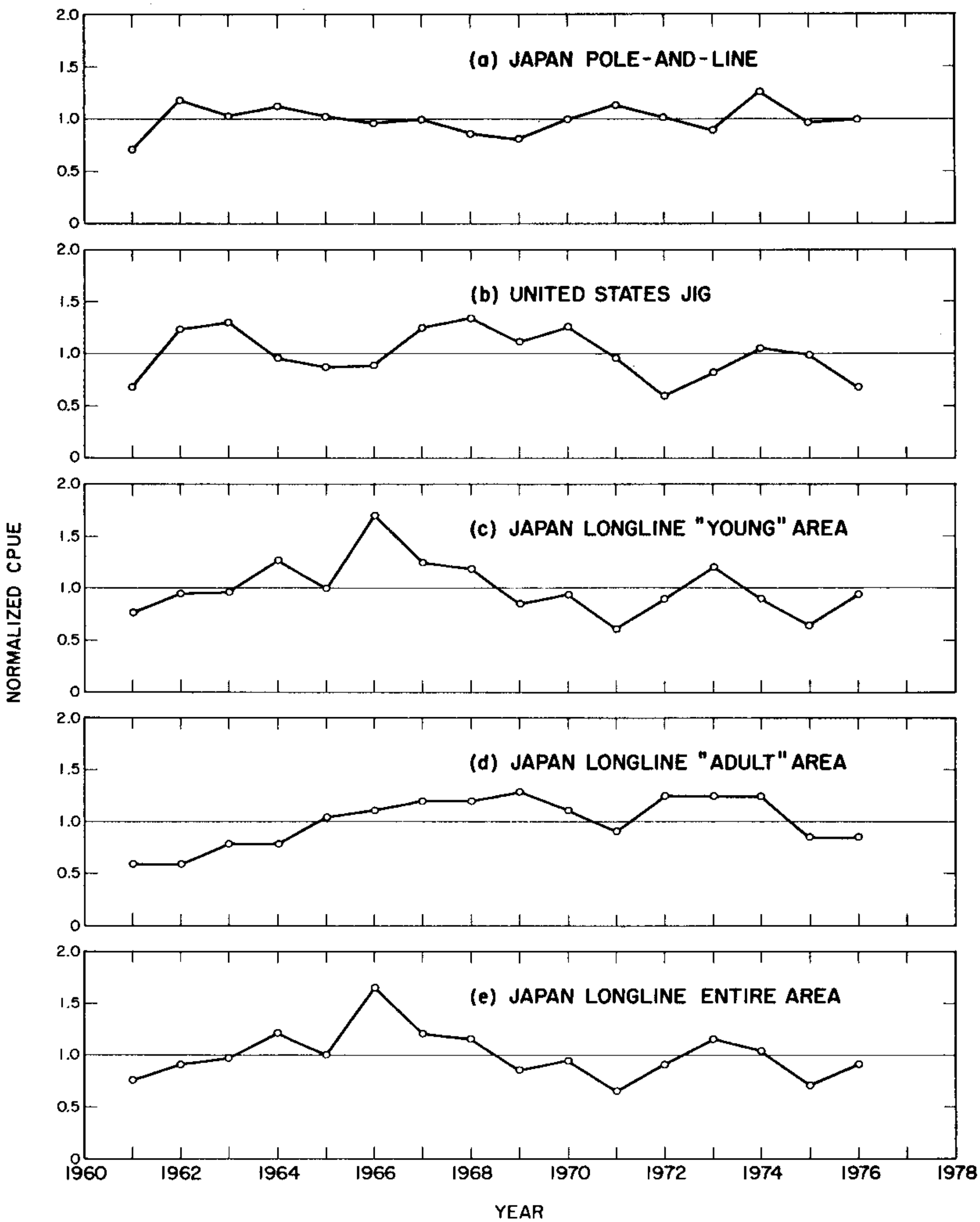

Figure 2.--Normalized catch per unit effort statistics for major North Pacific albacore fisheries, 1961-76.

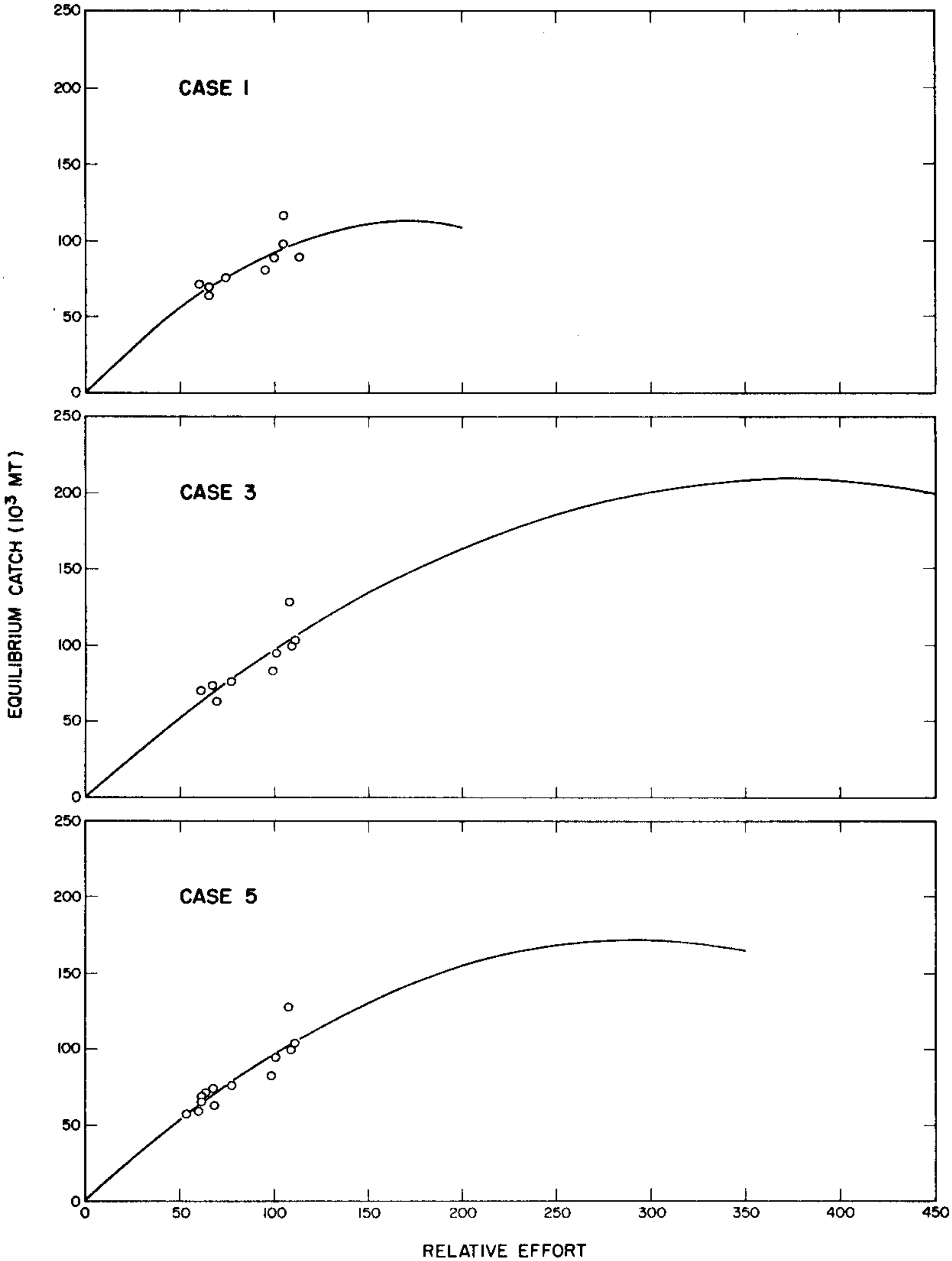

Figure 3.--Three production models for North Pacific albacore. Cases are described in Table 4.

Appendix A

LIST OF PARTICIPANTS

Norman Bartoo	National Marine Fisheries Service, La Jolla, California, U.S.A.
Fred Hagerman	California Department of Fish and Game, Long Beach, California, U.S.A.
Sigeiti Hayasi	Tohoku Regional Fisheries Research Laboratory, Shiogama-shi, Miyagi Prefecture, Japan
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Keith Ketchen	Fisheries and Environment Canada, Pacific Biological Station, Nanaimo, B.C., Canada
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Marian Y. Y. Yong	National Marine Fisheries Service, Honolulu, Hawaii, U.S.A.

Appendix B

AGENDA AND SCHEDULE

September 13 - 0900-1200

1. Introductory remarks, selection of workshop chairman and rapporteurs

2. Adoption of workshop agenda and schedule

3. Review of North Pacific albacore fisheries, 1977-78

   - Japan report
   - United States report
   - Canada report
   - Exchange and distribution of data on catch, fishing effort, catch size composition, vessel statistics, etc.
   - Completion and updating of basic fishery data tables

September 13 - 1300-1700

4. Presentation and discussion of working papers

   a. NPALB/78/WP-1 Stock assessment of North Pacific albacore by production model analysis (T. Shiohama)

   b. NPALB/78/WP-2 The present situation of the prediction of summer albacore pole-and-line fishery in the northwestern Pacific (T. Shiohama)

   c. NPALB/78/WP-5 Use of age-specific abundance indices and effective effort statistics to assess the North Pacific albacore stock - Preliminary results (J. Wetherall and M. Yong)

   d. NPALB/78/WP-3 Considerations on the fishing conditions in the surface albacore fishery in 1977 and 1978 (S. Kikawa)

   e. NPALB/78/WP-6 Some factors affecting the 1977 U.S. albacore fishery (R. M. Laurs)

   f. NPALB/78/WP-4 The results of the oceanographic observations by the R/V *Shoyo Maru* in the fishing ground in the Kuroshio Extension area (J. Morita)

g. NPALB/78/WP-7 Albacore otolith/tetracycline study to evaluate otolith daily ring increment method for growth determination - progress report (R. M. Laurs)

<u>September 14 - 0900-1100</u>

5. Evaluation of findings and drafting of summary statement on status of stock, fishing conditions, etc.

6. Discussion of research needs and recommendations

<u>September 14 - 1400-1600</u>

7. Adoption of draft workshop report

8. Plans for next meeting

9. Adjournment

Appendix C

LIST OF DOCUMENTS

Data

NPALB/78/D-1 - Catches of North Pacific albacore in metric tons, 1961-1976

NPALB/78/D-2 - Catch per unit of effort (CPUE) of North Pacific albacore by fishery

NPALB/78/D-3 - Number of Japanese pole-and-line albacore vessels by size

NPALB/78/D-4 - Sample length composition of U.S. albacore landings, 1976

NPALB/78/D-5 - Sample length composition of U.S. albacore landings, 1977

NPALB/78/D-6 - U.S. albacore landings in pounds by year, month, and state

NPALB/78/D-7 - Annual estimates of catch, effort, fishing intensity and CPUE of albacore caught by longline vessels (over 20 tons in size), 1952-1976 (T. Shiohama)

NPALB/78/D-8 - Catches of North Pacific albacore in metric tons, 1969-1976

NPALB/78/D-9 - Japanese albacore landings by various fishing methods, 1969-1976

NPALB/78/D-10 - Japanese pole-and-line length-frequency data, 1974-1976

NPALB/78/D-11 - Japanese longline length-frequency data, 1974-1976

Working Papers

NPALB/78/WP-1 - Stock assessment of North Pacific albacore by production model analysis (T. Shiohama)

NPALB/78/WP-2 - The present situation of the prediction of summer albacore pole-and-line fishery in the northwestern Pacific (T. Shiohama)

NPALB/78/WP-3 - Considerations on the fishing conditions in the surface albacore fishery in 1977 and 1978 (S. Kikawa)

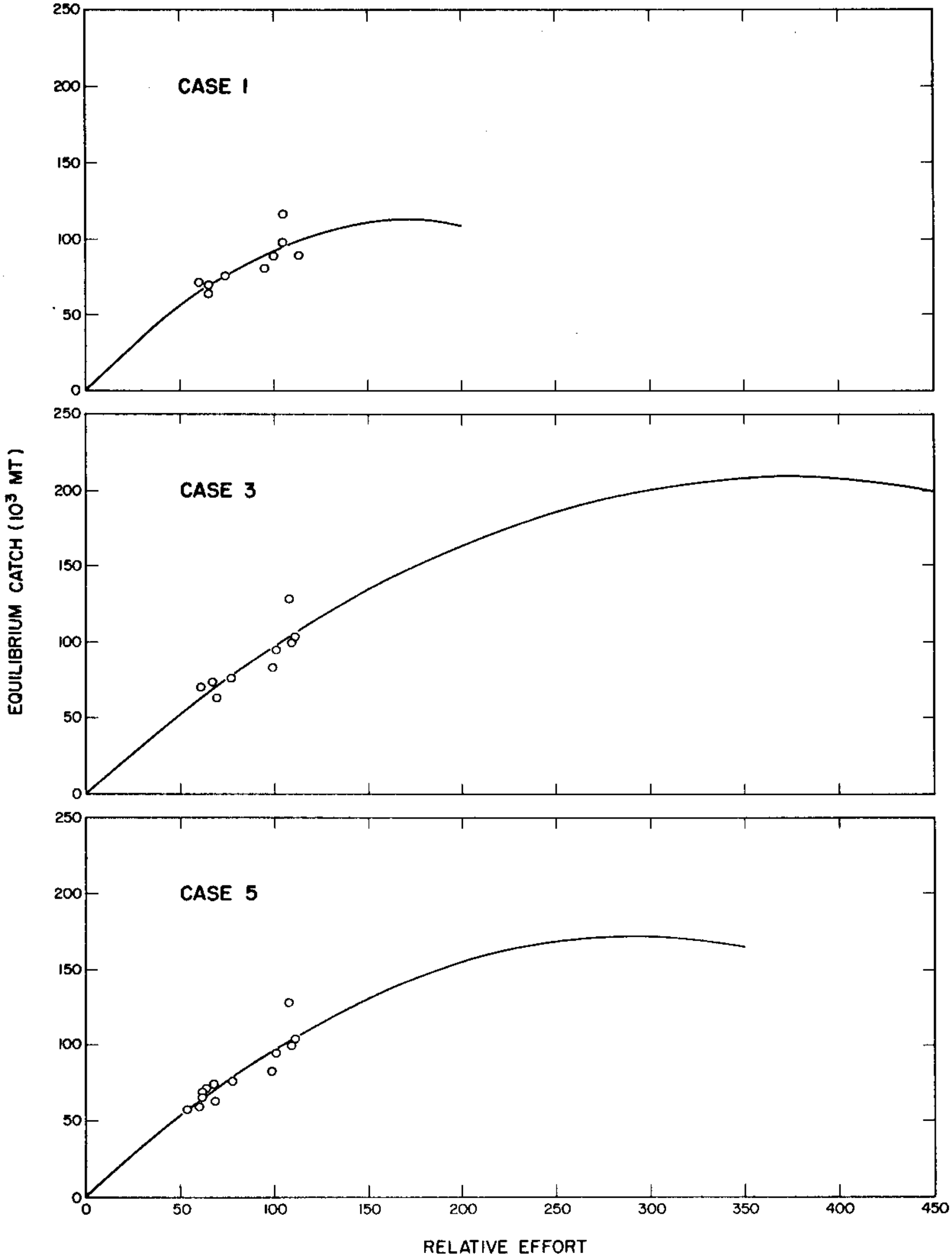

Figure 3.--Three production models for North Pacific albacore. Cases are described in Table 4.